Chapter 7
Nanocellulose Composites as Chemo-/Bio-Sensing Agents and Polymeric Matrixes: A Nanotechnological Application

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ABSTRACT

This chapter highlights the nanocellose-based composite sensors as powerful tools in multiple sensing/detecting applications and polymeric matrixes. The worldwide need for rapid, precise/accurate, selective/specific detection positions the nanosensors as crucial devices for sensing purposes. The authors discuss the basic sensor conception, a basic architecture applied in different spatial scales and research areas, such as environmental sciences, medicine, and optoelectronics. Chemo- and biosensors are also described in the chapter. The use of nanocellulose as supporting or embedding material in sensors and polymeric matrixes gives the attributes of this noble material, which, combined with active and sensitive materials at the nanoscale, assemble new opportunities in the sensors field.

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INTRODUCTION

For decades, the use of petroleum-based products, wasteful consumption, and the evident environmental challenge has promoted the development of *sustainable alternatives*. All those alternatives keep in common characteristics such as renewability, biocompatibility, biodegradability, and environmental friendliness. In this sense, nature brings the possibility of a broad range of *sustainable alternatives* like chemical compounds that have been employed as support materials for diverse anthropic activities to improve living conditions or life quality. Among these compounds, we can find cellulose, a natural polymer with thousands of applications and outstanding properties that has maintained its position as an essential building block material in fields such as engineering, material science, electronics, energy, and, nowadays, nanotechnology.(Kim et al., 2015) Many articles, reviews, and book chapters have described in detail the properties, structure, and composition of materials obtained from higher plants, mainly composed of hemicellulose, lignin, and cellulose. (Tayeb et al., 2018) All those reports agree that cellulose is the most abundant biopolymer (polysaccharide, ~ 3000 glucose units) in nature, represents a large fragment of available carbon on Earth, is an essential component of the cell walls composed of β-1,4-glucan chains, confers mechanical properties to derived-plant fibers and plants itself, its structure is hierarchical with a helical arrangement of microfiber and nanofibers with two clearly defined non/crystalline domains as a result of the biosynthesis process. (Heinze, 2015) Additionally, it can be obtained from nature by physical, chemical, or biological methods, and it works as the source of materials for the conception of high-performance composite materials. (Nechyporchuk & Belgacem, 2016) In this field, these new composites appear due to nanocellulose *(NC)* properties and their possibilities, opening the door to developing engineering materials that improve current composites with the sustainable concept always in mind. (Kumar et al., 2022) The term NC is mainly referred to as nanocellulose nanocrystals (CNCs), cellulose nanofibrils (CNFs), and bacterial cellulose (BC), three kinds of materials with length or widths in the nanoscale (1-100 nm) which confer nanoscale advantages such as high-specific surface area, high aspect ratio, unique mechanical behavior, high strength, flexibility, and low density. (Singh & Kumar, 2017) This chapter intends to describe the conjugation of nanocellulose properties in chemical/biological sensing platforms and polymeric matrixes as an example of the nanotechnological scope of these composites. In order to understand the opportunities of nanosensors, we will focus on the basic conception of sensors, sensing agents, recent progress in nanocellulose-based sensors, chemosensing, and biosensing.